R309-535 Miscellaneous Treatment Methods (Effective May 1, 2001)

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R309-535. Facility Design and Operation: Miscellaneous Treatment Methods.

R309-535-1. Purpose.

The purpose of this rule is to provide specific requirements for miscellaneous water treatment methods which are primarily intended to remove chemical contaminants from drinking water; or, adjust the chemical composition of drinking water. It is intended to be applied in conjunction with other rules, specifically R309-500 through R309-550. Collectively, these rules govern the design, construction, operation and maintenance of public drinking water system facilities. These rules are intended to assure that such facilities are reliably capable of supplying adequate quantities of water which consistently meet applicable drinking water quality requirements and do not pose a threat to general public health.

R309-535-2. Authority.

This rule is promulgated by the Drinking Water Board as authorized by Title 19, Environmental Quality Code, Chapter 4, Safe Drinking Water Act, Subsection 104(1)(a)(ii) of the Utah Code and in accordance with 63-46a of the same, known as the Administrative Rulemaking Act.

R309-535-3. Definitions.

Definitions for certain terms used in this rule are given in R309-110 but may be further clarified herein.

R309-535-4. General.

For each process described in this section pertinent rules are given. The designer must also, however, incorporate the relevant rules given in other sections into the plans and specifications for any of these specialized treatment methods. Where applicable, the following topics must be addressed:

(1) Plant Siting (see R309-525-6).

(2) Plant Reliability (see R309-525-7).

(3) Color Coding and Pipe Marking (see R309-525-8).

(4) Chemical Addition (see R309-525-11).

(5) Miscellaneous Plant Facilities (see R309-525-17, particularly sub-section R309-525-17(1), Laboratory).

(6) Operation and Maintenance Manuals (see R309-525-19).

(7) Safety (see R309-525-21).

(8) Disposal of Treatment Plant Waste (see R309-525-23).

(9) Disinfection (see R309-520).

R309-535-5. Fluoridation.

Sodium fluoride, sodium silicofluoride and fluorosilicic acid shall conform to the applicable AWWA standards and/or ANSI/NSF Standard 60. Other fluoride compounds which may be available must be approved by the Executive Secretary.

(1) Fluoride compound storage.

Fluoride chemicals should be isolated from other chemicals to prevent contamination. Compounds shall be stored in covered or unopened shipping containers and should be stored inside a building. Unsealed storage units for fluorosilicic acid should be vented to the atmosphere at a point outside any building. Bags, fiber drums and steel drums should be stored on pallets.

(2) Chemical feed equipment and methods.

In addition to the requirements in R309-525-11 "Chemical Addition", fluoride feed equipment shall meet the following requirements:

(a) scales, loss-of-weight recorders or liquid level indicators, as appropriate, accurate to within five percent of the average daily change in reading shall be provided for chemical feeds,

(b) feeders shall be accurate to within five percent of any desired feed rate,

(c) fluoride compound shall not be added before lime-soda softening or ion exchange softening,

(d) the point of application of fluorosilicic acid, if into a horizontal pipe, shall be in the lower half of the pipe,

(e) a fluoride solution shall be applied by a positive displacement pump having a stroke rate not less than 20 strokes per minute,

(f) a spring opposed diaphragm type anti-siphon device shall be provided for all fluoride feed lines and dilution water lines,

(g) a device to measure the flow of water to be treated is required,

(h) the dilution water pipe shall terminate at least two pipe diameters above the solution tank,

(i) water used for sodium fluoride dissolution shall be softened if hardness exceeds 75 mg/l as calcium carbonate,

(j) fluoride solutions shall be injected at a point of continuous positive pressure or a suitable air gap provided,

(k) the electrical outlet used for the fluoride feed pump should have a nonstandard receptacle and shall be interconnected with the well or service pump,

(l) saturators should be of the upflow type and be provided with a meter and backflow protection on the makeup water line.

(3) Secondary controls.

Secondary control systems for fluoride chemical feed devices shall be provided as a means of reducing the possibility for overfeed; these may include flow or pressure switches or other devices.

(4) Protective equipment.

Personal protective equipment as outlined in R309-525-11(10) shall be provided for operators handling fluoride compounds. Deluge showers and eye wash devices shall be provided at all fluorosilicic acid installations.

(5) Dust control.

(a) Provision must be made for the transfer of dry fluoride compounds from shipping containers to storage bins or hoppers in such a way as to minimize the quantity of fluoride dust which may enter the room in which the equipment is installed. The enclosure shall be provided with an exhaust fan and dust filter which place the hopper under a negative pressure. Air exhausted from fluoride

handling equipment shall discharge through a dust filter to the outside atmosphere of the building.

(b) Provision shall be made for disposing of empty bags, drums or barrels in a manner which will minimize exposure to fluoride dusts. A floor drain should be provided to facilitate the hosing of floors.

(6) Testing equipment.

Equipment shall be provided for measuring the quantity of fluoride in the water. Such equipment shall be subject to the approval of the Executive Secretary.

R309-535-6. Taste and Odor Control.

Part 4, Section 4.9, Taste and Odor Control, in the Recommended Standards for Water Works (commonly known as "Ten State Standards"), 1997 edition is hereby incorporated by reference and shall govern the design and operation of taste and odor control facilities. This document is published by the Great Lakes-Upper Mississippi River Board of Public Health and Environmental Managers. A copy is available in the office of the Division for reference.

R309-535-7. Stabilization.

Part 4, Section 4.8, Stabilization, in the Recommended Standards for Water Works (commonly known as "Ten State Standards"), 1997 edition is hereby incorporated by reference and it shall govern the design and operation of stabilization facilities. This document is published by the Great Lakes-Upper Mississippi River Board of Public Health and Environmental Managers. A copy is available in the office of the Division for reference.

R309-535-8. Deionization.

Current practical methods of deionization include Ion Exchange, Reverse Osmosis and Electrodialysis. Additional methods of deionization may be approved subject to the presentation of evidence of satisfactory reliability.

All properly developed groundwater sources having water quality exceeding 2,000 mg/l Total Dissolved Solids and/or 500 mg/l Sulfate shall be either properly diluted or treated by the methods outlined in this section. Deionization cannot be considered a substitute process for conventional complete treatment outlined in R309-525.

(1) Ion Exchange.

(a) General.

Great care shall be taken by the designer to avoid loading the media with water high in organics.

Guidance: Deionization using ion exchange has generally been high in chemical costs but low in maintenance and capital costs. Pretreatment may be necessary depending on the source of supply. Organic contamination may irreversibly foul the ion exchange resin if adequate precautions are not observed. This design is generally less sensitive to the presence of iron and manganese. Since ion exchange can produce water very low in Total Dissolved Solids, blending is sometimes appropriate.

(b) Design.

(i) Pretreatment shall be provided per the manufacturer's recommendation.

(ii) Upflow or down flow units are acceptable.

(iii) Exchangers shall have at least a three foot media depth.

(iv) Exchangers shall be designed to meet the recommendations of the media manufacturer with regard to flow rate or contact time. In any case, flow shall not exceed seven gpm/sf of bed area. The plant shall be provided with an influent or effluent meter as well as a meter on any bypass line.

(v) Chemical feeders used shall conform with R309-525-8. All solution tanks shall be covered.

(vi) Regenerants added shall be uniformly distributed over the entire media surface of upflow or downflow units. Regeneration shall be according to the media manufacturer's recommendations.

Guidance: Safety precautions should be observed around concentrated acids and bases.

(vii) The wash rate capability shall be in excess of the manufacturers recommendation and should be at least six to eight gpm/sf of bed area.

Guidance: Care should be taken in the design to prevent the loss of media during washing.

(viii) Disinfection (see R309-520) shall be required ahead of the exchange units where this does not interfere with the media.

Guidance: This often improves filtration by minimizing bacterial growth or slimes.

Where disinfection interferes with the media, disinfection shall follow the treatment process.

(c) Waste Disposal.

Waste generated by ion exchange treatment shall be disposed of in accordance with R309-525-23.

(2) Reverse Osmosis.

(a) General.

The design shall permit the easy exchange of modules for cleaning or replacement.

Guidance: Reverse Osmosis (R.O.) has generally been low in chemical and maintenance cost but high in energy and capital costs. In general, experience indicates that modules have a maximum service life of about three years under ideal conditions. Replacement of these modules should be scheduled with the water system management when the flux decreases to an unacceptable limit and/or when the operating pressure requirements become excessive. Generally twenty to sixty-seven percent of the feed water is required to carry off the concentrated waste. The designer is cautioned that Hollow Fiber modules are sensitive to damage by chlorine.

(b) Design Criteria.

(i) Pretreatment shall be provided per the manufacturer's recommendation.

Guidance: PH adjustment of the feed water to pH 5.5 is recommended when cellulose acetate (spiral wound) modules are used. Softening or pH adjustment is satisfactory pretreatment for hollow fiber modules.

(ii) Required equipment includes the following items: pressure gauges on the upstream and downstream side of the filter; a conductivity meter present at the site; taps for sampling permeate, concentrate and blended flows (if practiced). If a continuous conductivity meter is permanently installed, piping shall be such that the meter can be disconnected and calibrated with standard solutions at a frequency as recommended by the manufacturer.

(iii) Aeration, if practiced, shall conform with provisions of R309-535-9.

(iv) Cleaning shall be routinely done in accordance with the manufacturer's recommendations.

(v) Where the feed water pH is altered, stabilization of the finished water is mandatory.

(c) Waste Disposal.

Waste generated by reverse osmosis treatment shall be disposed of in accordance with R309-525-23.

(3) Electrodialysis.

(a) General.

Guidance: Past electrodialysis units have experienced high maintenance cost relative to the two desalinization methods mentioned previously. Where maintenance is readily available, this method may be cost effective. Experience has shown stacks must be disassembled and cleaned every two-four weeks depending on the source quality and operating conditions. Generally ten to thirty percent of the feed water is required to carry off the concentrated waste products. The designer should be cautioned that electrodialysis membranes may be damaged by the presence of chlorine.

(b) Design.

(i) Pretreatment shall be provided per the manufacturers recommendation.

Guidance: Generally the same pretreatment necessary for reverse osmosis (R.O.) is required for electrodialysis. However, feed water may be heated to near 180 degrees Fahrenheit to improve performance and should be free of iron, manganese, or organics.

(ii) The design shall include ability to: measure plant flow rates; measure feed temperature if the water is heated (a high temperature automatic cutoff is required to prevent membrane damage); measure D.C voltage at the first and second stages as well as on each of the stacks. Sampling taps shall be provided to measure the conductivity of the feed water, blowdown water, and product water. D.C. and A.C. kilowatt-hour meters to record the electricity used shall also be provided.

(c) Waste Disposal.

Waste generated by electrodialysis treatment shall be disposed of in accordance with R309-525-23.

R309-535-9. Aeration.

Part 4, Section 4.5, Aeration, in the Recommended Standards for Water Works (commonly known as "Ten State Standards"), 1997 edition, is hereby incorporated by reference and shall govern the design and operation of aeration facilities. This document is published by the Great Lakes-Upper Mississippi River Board of Public Health and Environmental Managers. A copy is available in the office of the Division for reference.

R309-535-10. Softening.

Part 4, Section 4.4, Softening, in the Recommended Standards for Water Works (commonly known as "Ten State Standards"), 1997 edition, is hereby incorporated by reference and shall govern the design and operation of softening facilities. This document is published by the Great Lakes-Upper Mississippi River Board of Public Health and Environmental Managers. A copy is available in the office of the Division for reference.

R309-535-11. Iron and Manganese Control.

Iron and manganese control, as used herein, refers solely to treatment processes designed specifically for this purpose. The treatment process used will depend upon the character of the source water. The selection of one or more treatment processes shall meet specific local conditions as determined by engineering investigations, including chemical analyses of

representative samples of water to be treated, and receive approval of the Executive Secretary. It may be necessary to operate a pilot plant in order to gather all information pertinent to the design. Consideration should be given to adjust the pH of the raw water to increase the rate of the chemical reactions involved.

Removal or treatment of iron and manganese are normally by the following methods:

(1) Removal by Oxidation, Detention and Filtration.

(a) Oxidation.

Oxidation may be by aeration, or by chemical oxidation with chlorine, potassium permanganate, ozone or chlorine dioxide.

(b) Detention.

(i) Reaction time - A minimum detention time of twenty minutes shall be provided following aeration in order to insure that the oxidation reactions are as complete as possible. This minimum detention may be omitted only where a pilot plant study indicates no need for detention. The detention basin shall be designed as a holding tank with no provisions for sludge collection but with sufficient baffling to prevent short circuiting.

(ii) Sedimentation - Sedimentation basins shall be provided when treating water with high iron and/or manganese content, or where chemical coagulation is used to reduce the load on the filters. Provisions for sludge removal shall be made.

(c) Filtration.

(i) General - Minimum criteria relative to number, rate of filtration, structural details and hydraulics, filter media, etc., provided for rapid rate gravity filters shall apply to pressure filters where appropriate, and may be used in this application but cannot be used in the filtration of surface waters or following lime-soda softening.

(ii) Details of Design for Pressure Filter - The filters shall be designed to provide for:

(A) Loss of head gauges on the inlet and outlet pipes of each filter,

(B) An easily readable meter or flow indicator on each battery of filters,

Guidance: A flow indicator is recommended for each filtering unit.

(C) Filtration and backwashing of each filter individually with an arrangement of piping as simple as possible to accomplish these purposes,

(D) The top of the washwater collectors to be at least twenty-four (24) inches above the surface of the media,

(E) The underdrain system to efficiently collect the filtered water and to uniformly distribute the backwash water at a rate capable of not less than 15 gpm/sf of filter area,

(F) Backwash flow indicators and controls that are easily readable while operating the control valves,

(G) An air release valve on the highest point of each filter,

(H) An accessible manhole to facilitate inspections and repairs,

(I) Means to observe the wastewater and filters during backwashing, and

(J) Construction to prevent cross-connection.

(2) Removal by the Lime-soda Softening Process.

For removal by the lime-soda softening process refer to Part 4, Section 4.4, Softening, in the Recommended Standards for Water Works (commonly known as "Ten State Standards"), 1997 edition as indicated in R309-535-10.

(3) Removal by Manganese Greensand Filtration.

This process, consisting of the continuous feed of potassium permanganate to the influent of a manganese greensand filter, is more applicable to the removal of manganese than the removal of iron.

(a) Provisions shall be made to apply the permanganate as far ahead of the filter as practical and at a point immediately before the filter.

Guidance: Other oxidizing agents or processes such as chlorination or aeration may be used prior to the permanganate feed to reduce the cost.

(b) An anthracite media cap of at least six inches shall be provided over manganese greensand.

(c) The normal filtration rate is three gpm/sf.

(d) The normal wash rate is 8 to 10 gpm/sf.

(e) Air washing shall be provided.

(f) Sample taps shall be provided:

(i) prior to application of permanganate,

(ii) immediately ahead of filtration,

(iii) at a point between the anthracite media and the manganese greensand,

(iv) halfway down the manganese greensand, and

(v) at the filter effluent.

(4) Removal by Ion Exchange.

This process is not acceptable where either the source water or wash water contains dissolved oxygen.

Guidance: This process of iron and manganese removal should not be used for water containing more than 0.3 milligrams per liter of iron, manganese or combination thereof.

(5) Sequestration by Polyphosphates.

This process shall not be used when iron, manganese or a combination thereof exceeds 1.0 milligram per liter. The total phosphate applied shall not exceed 10 milligrams per liter as PO_4. Where phosphate treatment is used, satisfactory chlorine residuals shall be maintained in the distribution system and the following required:

(a) feeding equipment shall conform to the requirements of R309-525-11(7),

(b) stock phosphate solution shall be kept covered and disinfected by carrying approximately 10 mg/l free chlorine residual,

(c) polyphosphates shall not be applied ahead of iron and manganese removal treatment. If no iron or manganese removal treatment is provided, the point of application shall be prior to any aeration, oxidation or disinfection steps, and

(d) phosphate chemicals must comply with ANSI/NSF Standard 60.

Sampling taps shall be provided for control purposes. Taps shall be located on each raw water source, and on each treatment unit influent and effluent.

Waste generated by iron and manganese control treatment shall be disposed of in accordance with R309-525-23.

R309-535-12. New Treatment Processes or Equipment.

The policy of the Board is to encourage, rather than to obstruct, the development of new methods and equipment for the treatment of water. Nevertheless, any new processes or equipment must have been thoroughly tested in full-scale, comparable installations, before approval of plans can be issued. The U.S. Environmental Protection Agency (EPA) has created the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. NSF International (NSF) in cooperation with the EPA operates the Package Drinking Water Treatment Systems (PDWTS) pilot, one of 12 technology areas under ETV. Engineers and Manufacturers are referred to Bruce Bartley, Manager, ETV project, NSF International, P.O. Box 130140, Ann Arbor, Michigan 48113-0140.

Guidance: Any municipality, water district, or institution purchasing novel equipment should be amply protected by a performance bond or other acceptable arrangement, so that any expenditure of money will be refunded in case of failure of any process or equipment. The performance bond should include provisions to cover the cost of any alterations deemed necessary by the Executive Secretary.

No new treatment process will be approved for use in Utah unless the designer or supplier can present evidence satisfactory to the Executive Secretary that the process will insure the delivery of water of safe, sanitary quality, without imposing undue problems of supervision, operation and/or control.

KEY: drinking water, miscellaneous treatment, stabilization, iron and manganese control
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